

Multimodal Alert Design

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Alerts at NASA



- Alert Types
 - **Emergency** - Time-critical event that requires immediate action and crew survival procedures
 - Fire
 - Rapid Depress
 - Toxic Atmosphere
 - **Warning** - an event that requires immediate action
 - **Caution** - an event that needs attention, but not immediate action
 - **Advisory**- A message that indicates a safe or normal configuration, indicates safe or normal operation of essential equipment, or imparts information for routine action purposes
- Auditory and Visual Annunciation
 - When an alert tone is annunciated, a message with more detail is displayed on a hardware panel or a computer display





Alert Requirements across Artemis



- Alert Tones
 - Orion Alert requirements (tones) selected to be common with ISS, but with improved sound characteristics
 - Gateway and HLS have adopted the same basic alert tone set to promote commonality and consistency
 - xEVA has adopted only the same Warning tone as the other vehicles
- Speech Alerts
 - ISS crew have requested improved alerts with a speech component
 - Past NASA research (2009/2010) on speech alerts found:
 - Speech alerts were recognized more quickly and were preferred
 - Crew advocacy for speech alerts
 - Too late in the Orion development cycle for inclusion
 - Gateway and HLS have requirements for Speech Alerts; Orion and xEVA do not
 - Requirements do not specify structure of speech alert
 - Risk of performance impact due to lack of consistency!





Alert Design Research



- Project Team
 - HRP team plus Artemis stakeholders
 - Informal partnership with Embry-Riddle/FAA Alerts project (Dr. Stephen Rice)
- Research Questions
 - **How does performance with a multimodal alert (tone + speech) compare to performance with a tone alert?**
 - **How is addition of a speech component impacted by type of task? (computer-based, speech-based)**
 - **Do the structure and features of the exemplar speech alerts meet stakeholder needs?**
 - Do context-specific tones (different set for each location) or a common set of tones (across all locations) yield faster and more accurate responses?





Approach to Research



- Review existing literature, including that already collected by Dr. Rice and his team (Embry-Riddle)
- Obtain representative alert types/messages from stakeholders
- Determine type of voice to use for speech alerts study
 - Synthetic vs. live?
 - Male vs. female?
- Determine basic structure of the speech alert – order of components, number of repetitions
- Create some exemplar alert messages and a demonstration application
- Perform studies
- Develop standards and guidelines for the design of speech alerts





Stakeholder Feedback and Testing



- Exemplar Messages
 - Message content iterated based on feedback from stakeholder group
- Voice Type
 - Synthetic speech – because easiest to modify
 - Speech messages with realistic (e.g., fan) background noise
 - Samples from macOS “VoiceOver” utility – part of accessibility features, edited with Adobe Audition
 - Team selected 2 male and 2 female voices for use in exemplar messages (*Matt, Tom, Sam, Ava*)
- Preference test with 21 stakeholders:
 - Instructions:
 - Listen to each speech alert message as many times as you want
 - Focus on the sound, not the content (although you can comment on that)
 - Provide ratings about suitability and intelligibility, and provide free-form comments

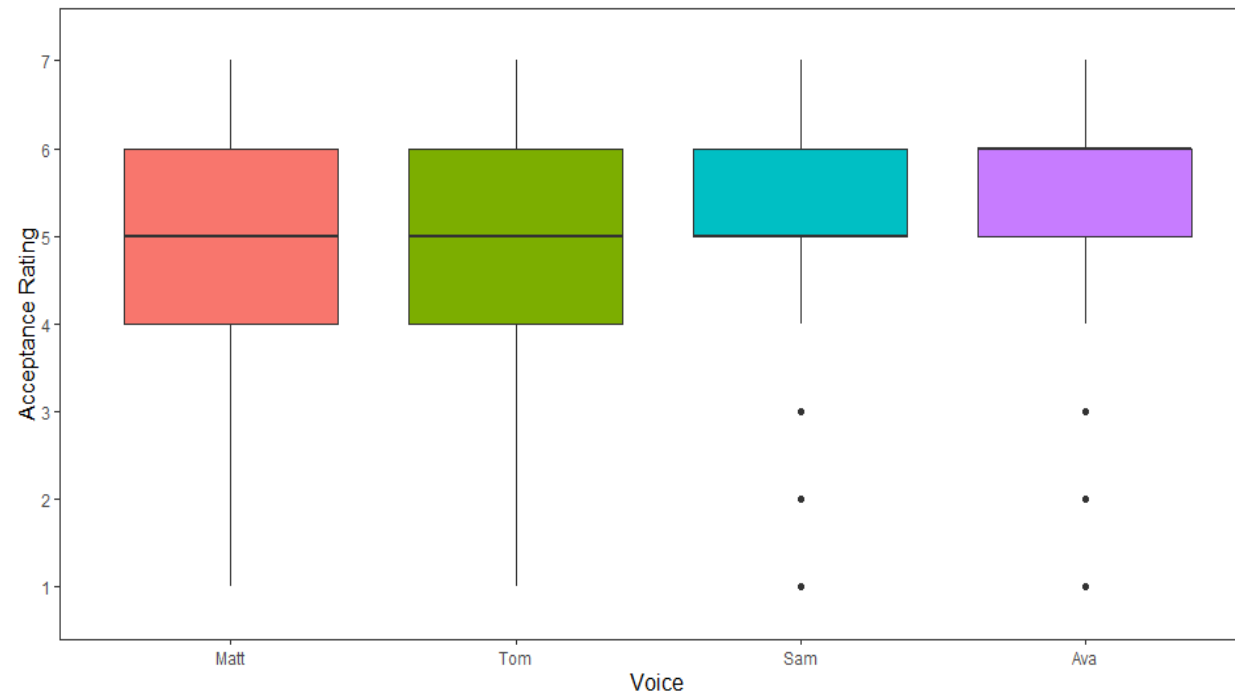




Preference Test Results



- Participants preferred female voices to male voices
 - Easier to hear in noisy environments due to higher pitch (Ji et al. 2019)
 - May have advantage in portraying varying levels of urgency (Edworthy et al., 2003)
- Overall preference for the *Ava* voice





Opportunity to Refine Requirements



- We provided recommendations for revision to the current speech alert requirements for HLS and Gateway
 - Tones already established and were consistent with Orion
 - Structure of the speech alert was recommended based on information in literature review and stakeholder inputs
 - Lead with the tone to get attention and readiness to listen to speech message – also for commonality with Orion
 - Quickly follow with verbal message starting with the signal word – e.g., EMERGENCY
 - Quickly follow that with the type of emergency and location – e.g., EMERGENCY FIRE HALO
 - Repeat the key bits of information – e.g., FIRE HALO
 - Repeat signal word, type and location as above – e.g., EMERGENCY FIRE HALO FIRE HALO
 - Repeat sequence until terminated by crew

Speech Alert Requirements Accepted by Both Programs!





Alerts Study 1 (2 sessions)



- Training Session:
 - Alert Tones
 - Speech Alerts
 - Operational tasks – interacting with vehicle subsystem displays
- Experimental Session
 - Perform 2 types of operational tasks while responding to alerts when they occur
 - Different actions associated with different alert types
 - Measures
 - Response time
 - Errors
 - Bedford Workload Scale
 - Subjective comments
- Study beginning now!



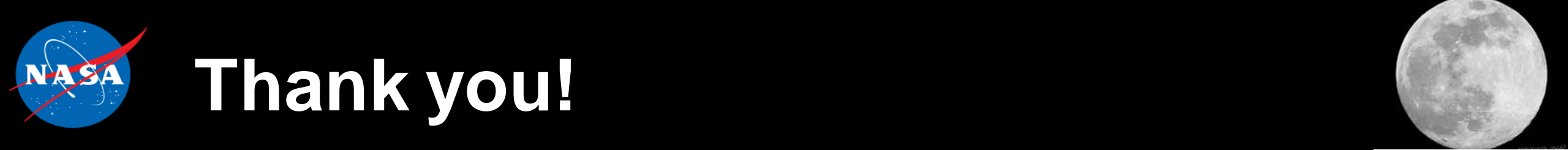


Radiation



Toxic Atmosphere





Thank you!

